WHAT IS CLAIMED IS:

1. A precipitation hardened structural assembly, comprising:

a first structural member;

a second structural member positioned adjacent to said first structural member such that said first and second structural members define an interface therebetween; and

at least one friction stir weld joint joining said first structural member to said second structural member at least partially along said interface, said first and second structural members and said friction stir weld joint being solution heat treated at a first predetermined temperature schedule and precipitation heat treated at a second predetermined temperature schedule and wherein said friction stir weld joint comprises a refined grain structure having grain size of less than about 5 microns.

2. A precipitation hardened structural assembly according to Claim 1 wherein said first and second structural members comprise dissimilar materials.

3. A precipitation hardened structural assembly according to Claim 1 where at least one of said first and second structural members is formed from materials selected from the group consisting of aluminum, aluminum alloys, titanium, and titanium alloys.

4. An apparatus for attachment to a rotatable spindle for forming a friction stir weld joint, comprising:

a friction stir welding tool in rotatable communication with the spindle, said friction stir welding tool defining a cavity; and

at least one heater adapted to thermally communicate with said friction stir welding tool to thereby heat said tool, said at least one heater being at least partially received in said cavity of said friction stir welding tool.

5. An apparatus according to Claim 4 wherein said at least one heater is selected from the group consisting of a resistance heating coil, an induction heating coil, a quartz lamp, a gas torch, and a laser.

6. An apparatus according to Claim 4 wherein said at least one heater thermally communicates with said friction stir welding tool through heat transfer selected from the group consisting of convection, conduction, irradiation and induction.

7. An apparatus according to Claim 4 further comprising a sensor in thermal communication with said friction stir welding tool for measuring the temperature of said friction stir welding tool.

8. An apparatus according to Claim 7 further comprising a controller in electrical communication with said sensor and in operable communication with said at least one heater, said controller configured to automatically modify the heat output of said at least one heater to modify the temperature of said friction stir welding tool.

9. An apparatus for friction stir welding at least one structural member, comprising:

a machine having a rotatable spindle;

a friction stir welding tool in rotatable communication with said spindle; and

at least one heater adapted to thermally communicate with said friction stir welding tool to thereby heat said tool, said at least one heater being structured so as to be electrically insulated from the at least one structural member.

10. An apparatus according to Claim 9 wherein said at least one heater is selected from the group consisting of a resistance heating coil, an induction heating coil, a quartz lamp, a gas torch, and a laser.

11. An apparatus according to Claim 9 wherein said friction stir welding tool defines a cavity adapted to at least partially receive said at least one heater.

12. An apparatus according to Claim 9 wherein said at least one heater thermally communicates with said friction stir welding tool through heat transfer selected from the group consisting of convection, conduction, irradiation and induction.

13. An apparatus according to Claim 9 wherein said at least one heater is spaced from said friction stir welding tool.

14. An apparatus according to Claim 9 further comprising a sensor in thermal communication with said friction stir welding tool for measuring the temperature of said friction stir welding tool.

15. An apparatus according to Claim 14 further comprising a controller in electrical communication with said sensor and in operable communication with said at least one heater, said controller configured to automatically modify the heat output of said at least one heater to modify the temperature of said friction stir welding tool.

16. A method of forming a friction stir weld joint, comprising:

mounting a friction stir welding tool to a rotatable spindle such that the friction stir welding tool rotates with the spindle;

heating the friction stir welding tool with at least one heater to thereby inhibit grain growth in the weld joint;

subsequent to said heating step, inserting the friction stir welding tool into at least one structural member; and

moving the friction stir welding tool through the at least one structural member to form the friction stir weld joint.

17. A method according to Claim 16 further comprising heating the friction stir welding tool concurrently with said inserting step.

18. A method according to Claim 16 further comprising precipitation hardening the at least one structural member at a predetermined temperature schedule prior to said inserting step.

19. A method according to Claim 16 further comprising solution heat treating the at least one structural member and friction stir weld joint at a predetermined temperature schedule subsequent to said moving step.

20. A method according to Claim 19 further comprising precipitation heat treating the at least one structural member and friction stir weld joint by aging at a second predetermined temperature schedule.

21. A method according to Claim 16 wherein said heating step comprises transferring heat to the friction stir welding tool through heat transfer selected from the group consisting of convection, conduction, irradiation, and induction.

22. A method according to Claim 16 wherein said heating step comprises heating the friction stir welding tool to a temperature between about 600 °F and about 1000 °F.

23. A method according to Claim 16 further comprising measuring the temperature of the friction stir welding tool.

24. A method according to Claim 23 further comprising automatically modifying the heat output of the at least one heater to thereby modify the temperature of the friction stir welding tool.

25. A method of manufacturing a structural assembly, comprising:

forming a friction stir weld joint in at least one structural member using a rotating friction stir welding tool to construct the structural assembly; and

heating the friction stir weld tool prior to and during said forming step with at least one heater to thereby inhibit grain growth in the weld joint.

26. A method according to Claim 25 further comprising repeating said forming and heating steps to thereby join at least one additional structural member to the structural assembly.

27. A method according to Claim 25 further comprising precipitation hardening the at least one structural member at a predetermined temperature schedule prior to said forming step.

28. A method according to Claim 25 further comprising solution heat treating the structural assembly at a predetermined temperature schedule subsequent to said forming step.

29. A method according to Claim 28 further comprising precipitation heat treating the structural assembly by aging at a second predetermined temperature schedule.

30. A method according to Claim 25 wherein said heating step comprises transferring heat to the friction stir welding tool through heat transfer selected from the group consisting of convection, conduction, irradiation, and induction.

31. A method according to Claim 25 wherein said heating step comprises heating the friction stir welding tool to a temperature between about 600 °F and about 1000 °F.

32. A method according to Claim 25 further comprising measuring the temperature of the friction stir welding tool.

33. A method according to Claim 32 further comprising automatically modifying the heat output of the at least one heater to thereby modify the temperature of the friction stir welding tool.